Fisheries and Oceans Pêches et Océans

Canadian Stock Assessment Secretariat
Research Document 98/106

Not to be cited without
permission of the authors[1]

Secrétariat canadien pour l'évaluation des stocks
Document de recherche 98/106

Ne pas citer sans
autorisation des auteurs[1]

STATUS OF THE ATLANTIC SALMON (*Salmo salar* L.) STOCK OF HUMBER RIVER, NEWFOUNDLAND, 1997

C.C. Mullins and D. Caines

Department of Fisheries and Oceans
Science Branch
1Regent Square
Corner Brook, Newfoundland
A2H 7K6

[1] This series documents the scientific basis for the evaluation of fisheries resources in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research documents are produced in the official language in which they are provided to the Secretariat.

[1] La présente série documente les bases scientifiques des évaluations des ressources halieutiques du Canada. Elle traite des problèmes courants selon les échéanciers dictés. Les documents qu'elle contient ne doivent pas être considérés comme des énoncés définitifs sur les sujets traités, mais plutôt comme des rapports d'étape sur les études en cours.

Les documents de recherche sont publiés dans la langue officielle utilisée dans le manuscrit envoyé au secrétariat.

ISSN 1480-4883
Ottawa, 1998

Canada

ABSTRACT

This is the eighth assessment of the Atlantic salmon stock of the Humber River. A mark-recapture estimate of the run size in 1997 indicated that the number of small salmon was 51% less than in 1996 and that the number of large salmon was 3% less than in 1996. The number of small salmon was the second lowest since 1992 but the number of large salmon was among the highest. The proportion of large salmon recorded at the tagging traps was the highest recorded in the period of assessment. The percentage of the spawning requirement achieved in 1997 was 115% (95% CI = 91% - 169%). The conservation requirement would not have been achieved if the proportion of large salmon had not increased from 1992-96 levels. Given the unexpected decrease in returns of small salmon in 1997, compared to 1996, any anticipation of returns in 1998 should be made with caution. Recreational harvests in 1998 should be closely monitored to avoid overexploiting the stock if the run size is below conservation requirements.

RÉSUMÉ

Il s'agit de la huitième évaluation du stock de saumon atlantique de la rivière Humber. Une estimation par marquage-recapture de l'effectif de la remontée de 1997 a montré que, par rapport à 1996, le nombre de petits saumons était inférieur de 51 % et celui de grands saumons de 3 %. Le nombre de petits saumons était le deuxième plus faible depuis 1992, mais celui des grands saumons comptait parmis les plus élevés. La proportion de grands saumons déterminée aux pièges de marquage a été la plus élevée de toute la période d'évaluation. Le pourcentage des besoins de géniteurs a atteint 115 % en 1997 (IC à 95 % = 91 %-169 %). Les besoins de conservation n'auraient pas été atteints si la proportion de grands saumons ne s'était pas accrue par rapport à la période 1992-1996. Étant donné la baisse imprévue des remontées de petits saumons en 1997, comparativement à 1996, toute prévision pour 1998 devrait être faite avec prudence. La récolte de la pêche récréative de 1998 devrait être contrôlée de près afin d'éviter de surexploiter le stock si l'effectif de la remontée s'avérait inférieur aux besoins de conservation.

INTRODUCTION

This is the eighth assessment of the status of the Humber River salmon stock since 1990. Prior to the closure of the commercial salmon fishery in 1992, the stock achieved 60% and 27% of egg deposition requirement in 1990 and 1991, respectively (Chaput and Mullins MS 1991, 1992). After the closure of the commercial fishery and the implementation of effort controls in the recreational fishery beginning in 1992, the stock has shown signs of improvement. The low population size in 1994, compared to other years since 1992 was attributed to extremely low spawning escapement in 1989 which would have produced most of the recruitment in 1994.

The Humber River is the largest river flowing into the Bay of Islands, Newfoundland at the northern limit of Salmon Fishing Area (SFA) 13 (Fig. 1). The Humber River flows into the Humber Arm at latitude 48° 57' N and longitude 57° 53' W. It comprises 95% of the total drainage area of the Bay of Islands (8,124 km^2) which is 57% of the total drainage area of SFA 13. The total length of all tributaries in the Humber River is 2,450 km. Complete obstructions to anadromous Atlantic salmon occur at Main Falls (Fig. 2) which is 112.6 km from the river mouth and at Junction Brook. Junction Brook, which flowed into the Humber River at Deer Lake was diverted for hydroelectric development in 1925, resulting in the loss of anadromous salmon habitat on the Grand Lake system (Porter et al., MS 1974) (see Fig. 2). No fish passage facility was provided for fish to bypass the diversion.

Commercial and recreational salmon fisheries management measures implemented in Newfoundland and Labrador since 1978 that would have influenced the Humber salmon stock are:

1. 1978 - commercial season shortened from 15 May - 31 December to 1 June - 10 July.
2. 1984 - mandatory release of large salmon (≥63 cm fork length) in recreational fishery.
3. 1987 - recreational season bag limit of 15 small salmon (<63 cm fork length).
4. 1990 - 35 t commercial quota in SFA 13 commercial fishery.
5. 1991 - 25 t commercial quota in SFA 13; recreational season bag limit of 10 small salmon.
6. 1992 - five year commercial moratorium; recreational quota of 5,000 small salmon in SFA 13 reached on 1 August; Adies Lake (Fig. 2) quota of 100 small salmon not reached; a catch and released fishery was permitted from 2 August to 7 September after the quota was reached; recreational season bag limit of eight small salmon.
7. 1993 - recreational quota of 5,200 small salmon in SFA 13 (4,160 for 5 June to 31 July and 1,040 for 1 August to 6 September) not reached; Adies Lake closed 31 July - quota of 100 small salmon not reached; daily bag limit of one fish; Cook's Brook was closed for the season.
8. 1994 - recreational season bag limit of three small salmon before 31 July and three after 31 July; Adies Lake closed 31 July - quota of 100 small salmon not reached; daily bag limit of two fish; daily catch and release limit of four fish.
9. 1995 - recreational season bag limit of three small salmon before 31 July and three after 31 July; Adies Lake closed 30 July - quota of 100 small salmon not reached; daily bag limit of two fish; daily catch and release limit of four fish.
10. 1996 - recreational season bag limit of three small salmon before 31 July and three after 31 July; Adies Lake closed 30 July - quota of 100 small salmon not reached; daily bag limit of two fish; daily catch and release limit of four fish; catch and release fall fishery permitted for the first time from 3-30 September.
11. 1997 - recreational season bag limit of three small salmon before 31 July and three after 31 July; Adies Lake closed 30 July - quota of 100 small salmon not reached; daily bag limit of two fish; daily catch and release limit of four fish; retention fishery closed on 27 July and catch and release permitted from 28 July to 1 Sept.; fall catch and release fishery 2-30 September.

The present assessment provides an estimate of Atlantic salmon returns and spawning escapements in 1997. The methodology closely follows that presented for previous assessments in 1990-96 (Mullins et al., 1998, in press; Mullins and Reddin, MS 1996; Mullins and Reddin, MS 1995; Mullins and Chaput, MS 1995; Mullins and Chaput, MS 1993; Chaput and Mullins, MS 1992; Chaput and Mullins, MS 1991).

MATERIALS AND METHODS

Recreational Fishery Harvest

The recreational catch of Atlantic salmon on the Humber River in 1997 was determined from the results of a creel survey at Big Falls (Fig. 2). Anglers leave the fishing area at Big Falls via only two exit points making it possible for creel survey clerks to observe 100% of the catch.

Each of the two exit points was monitored 16 hours per day in 1997. The sampling day at each exit was divided into two eight-hour time periods: 0600-1400 hours and 1400-2200 hours. A survey clerk was assigned to each time period throughout the fishing season. The clerks interviewed anglers as they exited the fishing area and recorded the number of hours fished and the number of salmon retained and released. They also collected biological samples and examined retained salmon for the presence of Carlin tags but this was secondary to recording the catch and effort information.

As in 1994 (Mullins and Reddin, MS 1995) and 1996, the 1997 survey was based on full coverage of the fishing area throughout the fishing season. The number of anglers interviewed in the survey was expressed in terms of rod days by subtracting the anglers that were interviewed more than once. The daily catches and effort were adjusted for the number of anglers and catch that remained on the river after the last survey period of the day and for the proportion of the total scheduled survey periods that were not surveyed. Some scheduled survey periods were not surveyed because of occasional illness of clerks. No adjustment was made for anglers that may have left the river before the start of the census day.

The total catch of retained small salmon on the Humber River in 1997 was derived from the creel survey results at Big Falls according to the equation:

$$C = C_{bf} / Prop_{bf}$$

Where:

C = Catch of retained small salmon on the Humber River
$\mathbf{C_{bf}}$ = Catch of retained small salmon at Big Falls based on the creel survey
$\mathbf{Prop_{bf}}$ = Number of tags returned voluntarily by anglers at Big Falls / Total number of tags returned voluntarily by anglers on the Humber River

Any bias in the voluntary tag reporting rate by anglers at Big Falls compared to other sections of the Humber River as a result of the presence of the creel survey clerks is believed to be minimal. Clerks were instructed not to prompt anglers in any way to return tags. Clerk also would not have observed all tags recovered at Big Falls because only fish sampled for biological information were examined closely. In addition, many anglers reported they did not observe tags in retained salmon until later examination away from the river.

The number of small salmon released on the Humber River in 1997 was estimated from the total catch of retained small salmon based on the relative proportions of small salmon retained and released at Big Falls in 1997.

The number of large salmon released on the Humber River in 1997 was estimated based on the number of large released at Big Falls and the proportion (0.354) of the total catch of large released at Big Falls in 1992-96 (Mullins et al., MS 1997). This proportion was derived from DFO catch statistics collected over the entire angling season in these years. Angling effort for large salmon in 1997, probably would not have been as affected by the closure of the retention fishery as would effort for released small salmon because the fishery for large salmon is generally later in the season when the effort for small salmon is much lower.

Recreational effort and catch of retained and released small (<63 cm) and large (≥63 cm) salmon prior to 1997 were observed and estimated by DFO river guardians and fisheries officers according to methods described by Mullins and Claytor, MS 1989 and Mullins et al., MS 1989. These statistics were not collected in 1997 so no comparison could be made with pervious years. It is cautioned that the effort and catch actually observed, as opposed to estimated by this method, declined since 1992 (Mullins and Reddin, MS 1996). Hence, the most recent years were only indirectly comparable to those previous.

Daily estimated catches and effort at Big Falls were summarized by standardized weeks.

Standardized Week	Time Period
22	May 28 - June 3
23	June 4 -10
24	June 11 - 17
25	June 18 - 24
26	June 25 - July 1
27	July 2 - 8
28	July 9 - 15
29	July 16 - 22
30	July 23 - 29
31	July 30 - August 5
32	August 6 - 12
33	August 13 - 19
34	August 20 to 26
35	August 27 - Sept. 2
36	Sept. 3 - 9

Estimation of Angling Exploitation Rate, Total Returns, Spawning Escapements and Potential Egg Deposition

Equations used to calculate estimates of angling exploitation, total catch and total returns are summarized in Table 1. Unless otherwise specified, confidence intervals around various estimated parameters were derived by simulation techniques. Each parameter was recalculated 5000 times by resampling at random from a binomial probability distribution dictated by the available data. The values corresponding to the 2.5^{th} and 97.5^{th} percentiles in the bootstrapped frequency distribution for each parameter were used as the lower and upper confidence limits, respectively. The bootstrap technique is described in detail by Diaconis and Efron (1983) and Efron and Tibshirani (1986).

a. Angling Exploitation Rate

Carlin tags were applied to salmon captured at two tagging traps operated in the estuary (Fig. 1). The **Lower** trap has been fished in the same location at Wild Cove, Humber Arm, since 1990. The

Upper trap was fished about 1.5 km upstream from the Lower trap (the same location as in 1993 and 1995). In the 1994 assessment this trap was fished approximately 10 km further upstream. The trap designs and installation in 1997 were identical to those in the 1990-96 assessments. Tags were applied using a double stainless steel wire attachment directly under the anterior end of the dorsal fin. All salmon captured in the two traps were measured (fork length 0.1 cm), and scale sampled. Injured salmon were not tagged. Both small and large salmon were tagged.

The estimated angling exploitation rate (***er***) for retained small salmon was based on tags recaptured in the angling fishery according to the formulae:

$$er = R / M$$

Where:

$$R = Rv / rr$$
$$M = Ma \times (1 - TL\ (0.009 \times \text{Median Days to Recapture}))$$
$$rr = \#\ \text{Tags Returned from Big Falls} / \#\ \text{Tags Recaptured at Big Falls}$$

Where:

R = Total number of recaptures by anglers
Rv = Number of recaptures reported voluntarily by anglers
Ma = Number of tags applied to small salmon
M = Number of tags available to angling
TL = Tag loss rate due to tag shedding
rr = Voluntary tag reporting rate by anglers

The voluntary reporting rate (rr) of tags by anglers was estimated from recaptures of small salmon observed by the creel survey clerks at Big Falls. Clerks were instructed to observe only and not to prompt anglers to return tags. Note: the ratio *(tags/catch at Big Falls) : (tags/catch for the rest of the river)* does not give a valid estimate of the reporting rate because it cannot be assumed that the creel clerks observed 100% of the tags recaptured at Big Falls.

The number of tags available (M) to the small salmon retention fishery were estimated from the number of tags applied (Ma), adjusted for the proportion of tags retained (1- Tag-Loss Rate), as in previous years. The tag-loss rate (TL) was estimated based on 0.009 tags shed per day at large which was derived for the Margaree River in 1992 (Chaput et al., MS 1993). The method of tag application in the Margaree tagging program was the same as for the Humber River. The median number of days at large for tagged fish was determined according to Sokal and Rohlf (1969). No adjustment was made to the number of tags available to account for tags removed from released small salmon because these tags would have also been available to the retention fishery for a period of time before being caught and released. In the 1995 assessment (Mullins and Reddin, MS 1996), if the number of tags available to the retention fishery had been adjusted for tags removed from released fish, the exploitation rate calculation would have increased by less than 1.5%.

b. Total Returns

The total number of small salmon (N_{sm}) was estimated based on total adjusted angling catch of small salmon retained and the angling exploitation rate according to the Petersen (Single Census) method (Ricker, 1975):

$$N_{sm} = C / er$$

The total number of large salmon (N_{lg}) was estimated from small salmon returns based on the proportion of small and large salmon captured in the two tagging traps:

$$N_{lg} = N_{sm} \ / \ Prop_{sm} - N_{sm}$$

In the 1990 and 1991 assessments, the relative proportions of small and large salmon returns was considered to be equivalent to the proportion observed in the recreational fishery prior to 1984 when large salmon could be retained (Chaput and Mullins, MS 1991, 1992). However, a commercial fishery was also permitted in these years. Because of the closure of the commercial fishery in 1992 and the potential for an increase in the proportion of large salmon, the relative proportions captured in the tagging traps was considered to be more representative of the true population value.

c. Spawning Escapements

The spawning escapements of small and large salmon were obtained by subtracting total angling removals from the total returns. Angling removals included retained small salmon and a 10% mortality rate on released small and large salmon.

d. Potential Egg Depositions

The potential egg deposition by small and large salmon in 1997 was calculated based on estimates of the number of eggs deposited per small and large female spawner. These estimates were derived from biological characteristics (mean weight of females and percent female) collected from the 1997 run and an estimate of the relative fecundity of small and large female spawners combined. The relative fecundity value used was 1,540 eggs/kg taken from (Porter and Chadwick, MS 1983). Small and large salmon can have different relative fecundity (Randall, 1989). However, the current estimate of the proportion of large salmon spawners in the Humber River stock is low on average (<10%) and age-specific fecundity estimates are lacking. The mean weight and percent female of small salmon were obtained from retained catches at Big Falls in 1997. These and other biological characteristics of Atlantic salmon on the Humber River are shown in Appendices 1-6. The mean weight of female large salmon was 3.7 kg (Porter and Chadwick, MS 1983) and the percentage female was 68.6% based on commercial catches in the Bay of Islands in 1991 (Mullins and Chaput, MS 1992).

Estimation of Conservation Requirements

The conservation egg deposition requirement was calculated based on an optimal egg deposition rate for fluvial (Porter and Chadwick, MS 1983) and lacustrine (Mullins and Chaput, MS 1995) parr rearing habitat. The egg deposition rate for fluvial habitat was 2.4 eggs/m^2 (Elson, 1957), which includes an adjustment for egg losses due to poaching and disease. The egg deposition rate for lacustrine habitat was 368 eggs/ha, as described by O'Connell et al. (MS 1991) which does not include an adjustment for poaching and disease.

The conservation requirement of 28.3 million eggs expressed in terms of number of spawners is 15,749 small and 934 large salmon (Mullins et al., MS 1997).

Long Term Population Trends

Analysis to Detect Recruitment Overfishing

Details of the analysis to detect recruitment overfishing is provided by O'Connell, et al. (1995). Spawning escapements that produced small and large salmon spawners on the Humber River in 1980-

1997 were constructed by weighting previous spawning escapements by the smolt age distribution of 1SW salmon on the Humber River in 1993.

RESULTS

Recreational Fishery Harvest

The recreational fishery on the Humber River in 1997 opened on 1 June and closed on 1 September. Angling was restricted to catch and release only from 28 July to the end of the season as a result of an in-season review that indicated returns in 1997 had declined from 1996. The Adies Lake (Fig. 2) quota of 100 small salmon retained was not reached. The Tailrace area of Deer Lake which was closed to angling for the first time in 1996 (29 July to 25 August) was reopened in 1997 but as part of the scheduled waters of the Humber River. The closure of the Tailrace in 1996 may have affected the total catch and effort for the river as well as the number of tag recaptures.

The 1997 creel survey at Big Falls was conducted from 24 June to 1 September. A total of 3,599 interviews were conducted with anglers as they exited the fishing area (including 311 interviews with anglers leaving for the second or third time on the same day) (Table 2). The peak of angling effort and catch occurred during the week 27 (2 July to 8 July) for the retention fishery which was one week later than in 1996 (Mullins et al., MS 1997).

Catch and effort dropped off considerably after the closure of the retention fishery on 27 July. Only about 3% of the total effort occurred during the period of the release fishery compared to 16% in the 1996 and 20% in 1994 creel surveys.

	Retention Fishery				Release Fishery			
		Small		Large		Small		Large
Year	Rods	Retained	Released	Released	Rods	Retained	Released	Released
1994	79.6	92.3	97.5	96.8	20.4	7.7	2.5	3.2
1996	83.7	95.5	96.7	98.6	16.3	4.5	3.3	1.4
1997	97.3	100.0	94.3	90.5	2.7	0.0	5.7	9.5

The observed catch of 1,009 retained small salmon in 1997 was 16% less than in the same period in 1996 but 43% more than in 1994.

	Retention Fishery				Release Fishery			
		Small		Large		Small		Large
Year	Rods	Retained	Released	Released	Rods	Retained	Released	Released
1994	5116	704	425	61	1312	59	11	2
1996	5405	1174	756	72	1047	55	26	1
1997	4431	1009	541	38	124	0	33	4

The proportion of small salmon released in 1997 was similar to the mean for 1994-96 when the season was split at 31 July based on tag allotments (Table 3). Anglers fished for an average of 8.3 hours to catch one fish in 1997 which was only 7% lower than the effort expended for one fish in 1996.

The survey clerks at Big Falls were successful in monitoring 96% of the scheduled survey periods during the retention fishery, 80% for the release fishery and 88% over the entire season (Table 4). After adjustment for the proportion of periods monitored, the total catch at Big Falls was 1,112 small retained (Table 5), 651 small released (Table 6) and 47 large salmon released (Table 7).

Returns, Spawning Escapement and Percentage of the Conservation Egg Deposition Achieved

a. Angling Exploitation Rate

The Lower tagging trap was operated from 10 June to 1 September and the Upper Trap was operated from 3 June to 3 September. A total of 384 small and 67 large bright salmon were captured in the two tagging traps (Table 8). This was less than the total catch in the previous four years but the proportion of large salmon increased by 61% from the 1992-96 mean.

A total of 369 (233 Lower and 136 Upper) small salmon were tagged and released and considered to be available to the retention fishery in 1997 (Table 9). The five small salmon tagged in week 31 at the Lower trap were not considered to be available to the retention fishery.

Tags were not applied at water temperatures above 15 C. Higher temperatures occurred in the later part of the run, hence, the difference in the recapture rate of tags could be either due to water temperature or to the closure of the retention fishery. However, because of the relatively cool temperatures at the time of tagging, the experience of tagging personnel, the fact that fish were submerged in water while being tagged and that injured fish were not tagged, tagging mortality was believed to be negligible. The tag application process takes approximately 45 seconds.

Similar distribution of catches of small salmon in both the Lower and Upper tagging traps indicated that the tagging occurred over the entire run in 1997 (Figs. 3a-b). Based on the distribution of catches, it does not appear likely that a large number of small or large salmon would have entered the river prior to the installation of the traps. The run timing of small salmon at the Lower Trap was the second earliest recorded in eight years of operation and the run timing of large salmon was among the latest (Fig. 4a-b).

The distribution of tags applied and recaptured in the retention fishery were the same for both tagging traps (Fig. 5a-b). The distribution of tagged and untagged small salmon in the retention fishery (Fig. 5c) indicated that tagged small salmon were evenly dispersed in the population and available to the fishery at the same time as untagged salmon.

A total of 37 Carlin tags were returned by anglers from retained and released small salmon in 1997 (Table 10). These were distributed throughout all major segments of the river with the largest number recaptured at Big Falls and Little Falls and Harriman's Steady. These areas also produced the highest number of tag recaptures in previous years. A total of 33 tags were considered to be from retained small salmon including one that was not reported as retained or released (Table 10). A total of 15 tagged small salmon were retained at Big Falls. There were no reported angling recaptures of large salmon.

Out of a total of 11 tags (retained and released) observed by the creel survey clerks at Big Falls, 63.64% (7/11) were returned voluntarily by anglers (Table 11). This was similar to the reporting rate estimated for previous years, as shown in the text table below.

Year	Reported Rate (%)
1994	64.0
1995	60.9
1996	60.7
1997	63.64

Zale and Bain (1994), in an estimate of the willingness of anglers to co-operate when given a certain level of reward, reported that under simulated conditions 64-67% of anglers voluntarily returned tags.

The median number of days at large for recaptured small salmon was 16 days (Table 12). This was four days longer than in 1996. The minimum days at large in 1997 was two and the maximum was 40 days. The estimated overall proportion of tags retained during this period was 0.856. After adjustment for tag loss and reporting rate, the angling exploitation rate on retained small salmon was estimated at 0.1646, similar to the 1996 value of 0.1557. The angling exploitation rate on the Humber River in the last two years was been the lowest in eight years of assessment (0.1846 in 1995; 0.2865 in 1994; 0.2213 in 1993; 0.22 in 1992; and 0.25 in 1990-91).

The early run timing of small salmon in the last two years (Fig. 4a) may have resulted in fish being available to the fishery for a shorter period of time due quick passage through the system. This would explain the low angling exploitation rates in 1996 and 1997 compared to previous years. The highest angling exploitation rate recorded in the period of assessment was in 1994. The total angling effort was lower in 1994 than in 1996 and 1997 but the run timing was later and occurred over a much longer time period. This may have resulted in the population being available to the fishery longer in 1994 than in 1996 and 1997 and, therefore, the exploitation rate was higher. The closure of the Tailrace portion of Deer Lake in 1996 would also have reduced angling exploitation.

It is noted that five Humber River small salmon tagged on 27-28 July 1995 and held in captivity until 23 November, had 0.0% tag loss at the time of release, 119 days after being tagged. Although this sample size is insufficient to estimate tag loss in the wild, a higher tag retention rate than estimated in Table 10 would have resulted in an even lower angling exploitation rate.

Angling exploitation was highest on small salmon tagged and released in week 24 (0.2941) and lowest on those tagged in week 26 (0.0926). The range of angling exploitation rates calculated in Table 12 indicates that, to some extent, the fishery harvested certain portions of the salmon run more than others. However, the numbers of fish tagged and recaptured varied greatly between these two release periods and would have biased the exploitation rate estimates. A stratified estimate of the population size based on weekly exploitation rates may yield a slightly different estimate than that based on a single exploitation rate for the season. However, with such low numbers of tags this would not be appropriate. In previous assessments, such stratified estimates, using the Darroch (1961) estimator, were not significantly different than the single census Petersen because pooling of release strata was necessary in order to obtain sufficient sample sizes for the estimator to work.

Three small salmon tagged and released in 1997 were recaptured at Hughes Brook (Fig.1). Hughes Brook flows into the Humber Arm about 3.0 km north of the Humber River estuary. Tagged small salmon were also recaptured in Hughes Brook in the past (2-12 in 1990-93). If a total of 12 small salmon had been subtracted from the number of small salmon tagged in 1997 to account for those destined for Hughes Brook, the angling exploitation rate estimate would have increased by 2.6% and the returns estimate would have been approximately 2.5% less (~329 small salmon). This was considered to be negligible and no adjustment was made to the angling exploitation rate.

b. Returns and Escapements of small and large salmon

As shown in the following text table, the Big Falls area produced almost 45.6% of the tag recoveries from retained small salmon on the Humber River in 1997. This is comparable with the percentage of tag returns from Big Falls in most years since 1992 and the 1992-96 mean. The percentage of tags returned from Big Falls is also comparable with the percentage of the Humber angling catch retained at Big Falls in some years but the decreased emphasis on the collection of angling catch statistics by DFO may have affected the calculation for recent years.

	Angling Catch			Tag Returns		
	Small salmon Retained			Small salmon Retained		
	Humber	Big Falls		Humber	Big Falls	
Year	N	N	%	N	N	%
1992	2234	1497	67.0	32	22	68.8
1993	2206	882	40.0	119	48	40.3
1994	1550	651	42.0	97	37	38.1
1995	1825	549	30.1	189	93	49.2
1996	2448	1237	50.5	79	25	31.6
1997	.	.	.	33	15	45.5
Mean (92-96)			45.9			45.6

The adjusted angling catch of retained small salmon in 1997 was 2,447 (95% CI = 1,748 - 3,670) (Table 13). Based on this catch and the angling exploitation rate of 0.1646 (95% CI = 0.1204 – 0.2725), it was estimated that 14,866 (95% CI = 11,340 – 19,501) small salmon entered the Humber River in 1997 (Table 14). Based on the proportion of small salmon caught in the tagging traps of 0.8514 (95% CI = 0.8180 – 0.8820), 2,595 (95% CI = 2,523 – 4,339) large salmon also entered the river in 1997 (Table 14).

The potential spawning escapement in 1997, after angling removals, was 12,276 (95% CI = 8,750 – 16,911) small and 2,582 (95% CI = 2,510 – 4,326) large salmon (Table 14). This escapement of small salmon was below the conservation spawner requirement for small, whereas the escapement of large salmon was above the conservation spawner requirement for large (Figs. 6a-b). The total potential egg depositions from these spawners was 115% (95% CI = 91% - 169%) of the conservation egg deposition requirement (Table 15), a decline of nearly 38% from 1996 (Table 16). If the proportion of small salmon observed in 1997 had been equivalent to the 1992-96 mean of 0.9221, the estimate of large salmon returns would have been 52% lower and the percentage of the conservation requirement achieved would have been 16% lower.

Long term Population Trends

Since the closure of the commercial salmon fishery in 1992, with the exception of 1994 and 1997, the number of spawners on the Humber River has generally been above estimates of their cohorts derived by weighting previous spawners by the smolt-age distribution of their progeny (Fig. 7).

Spawners were above the replacement (diagonal) line (Fig. 8) in four out of six years since 1992. In 1991 the number of spawners was well below the replacement line. Of the total of eight data points, two were below the replacement line indicating that the stock has been in an overall increasing trend in the time period examined.

DISCUSSION

The low returns of small Atlantic salmon to the Humber River in 1997 compared to 1995 and 1996 was unexpected because the number of recruits produced per spawner in the three previous years had increased. For example, returns to the river in 1995 and 1996 were about twice those expected based on the number of spawners, whereas, returns in 1997 were only equivalent to the spawners that

produced them. The decline in 1997, may have been due in part to natural variability in recruitment but because of the magnitude of the decline, compared to the previous year, it was more likely the result of a major change in survival rate.

Returns of large salmon did not decrease to the same degree as small salmon in 1997. This may have been due to the fact that large salmon are predominantly repeat spawning 1SWs and may not be subject to the same marine conditions as either returning virgin 1SW salmon or smolts. Large salmon on the Humber River are typically 30 to 40% virgin 2SW salmon. Therefore, returns of 2SW salmon in 1998 would also be expected to be low, given the low survival of 1SW salmon in 1997. However, if there has been a delay in age at maturity of small salmon, these fish would return as 2SWs in 1998 and could result in an increase in returns of large salmon. In addition, the first 2SW recruits from the 1992 year-class will return to the river in 1998.

In a stock with a healthy spawning population it is suggested that points in the spawner-recruit relationship described in Fig. 8 should fall both above and below the line in a 50:50 distribution. Five of the last eight years on the Humber have fallen above the replacement line. Also, in a healthy population, the conservation requirement should be achieved each year. In the case of the Humber this has occurred in only four of the last eight years but in four of the last six years since 1992. It is concluded from this that the Humber River salmon stock, while below the conservation requirement in some years, is showing signs of improvement. However, growth of the spawning population in 1997 was minimal. If the survival rate of year-classes contributing to returns to the river in 1998 is as low as for 1997 returns, then a second consecutive year of low population growth could be experienced in 1998. Because the potential for overexploiting the stock if the returns in 1998 are again low, angling exploitation in 1998 should be closely monitored.

The current assessment of the status of the Humber River Atlantic salmon stock is based on returns to the river in June to August. While these returns represent by far the majority of the stock size, there is evidence that a run of large salmon enters the river in the fall, presumably spawning in the lower part of the river. Mullins et al. (MS 1997) determined that the fall run consists of 2SW and 3SW salmon, as well as previous spawners and that the size of the run increased in 1994-96 compared to previous years. However, the population appeared to be low, probably less that 600 salmon, with the 3SW component probably less than 200 salmon. The 3SW component is unique to Newfoundland and should be given special protection to minimize and to prevent any increase in fishing mortality.

ACKNOWLEDGEMENTS

The operation of the two tagging traps in 1997 and the creel survey at Big Falls were funded in part by HRDC through the Grand Lake Centre of Economic Development. We are grateful for their continued support.

REFERENCES

Chaput, G. and C. Mullins. MS 1991. The status of the Atlantic salmon stock of Humber River/Bay of Islands Newfoundland, 1990. CAFSAC Res. Doc. 91/14, 28 p.

Chaput, G. and C. Mullins. MS 1992. The status of the Atlantic salmon stock of Humber River/Bay of Islands Newfoundland, 1991. CAFSAC Res. Doc. 92/28, 34 p.

Chaput G., R. Jones and C. C. Mullins. MS 1992. A practical assessment of bus route creel surveys and lattice sampling design for estimating the recreational catch of Atlantic salmon. CAFSAC Working Paper 92/16.

Chaput, G., R. Jones, L. Forsythe and P. Leblanc. MS 1993. Assessment of Atlantic salmon in the Margaree River, Nova Scotia, 1992. DFO Atl. Fish. Res. Doc. 93/14, 39 p.

Darroch, J. N. 1961. The two-sample capture-recapture census when tagging and sampling are stratified. Biometrika 48:241-260 p.

Dempson, J. B. and D. E. Stansbury. 1991. Using partial counting fences and a two-sample stratified design for mark-recapture estimation of an Atlantic salmon smolt production. North American Journal of Fisheries Management 11: 27-37 p.

Diaconis, P. and B. Efron. 1983. Computer-Intensive Methods in Statistics. Sci. Amer. Vol. 248 No. 5: 116-130 p.

Efron, B. and R. Tibshirani. 1986. Bootstrap Methods for Standard Errors, Confidence Intervals, and Other Measures of Statistical Accuracy. Statistical Science 1:54-75 p.

Hare Fisheries and Environmental Consultants. 1990. A strategy for enhancing and managing the Atlantic salmon resource in the Bay of Islands - Humber River ecosystem. Prepared for the Salmon Preservation Association for the waters of Newfoundland (SPAWN), 53 p.

Mullins, C. C. and R. R. Claytor. MS 1989. Recreational Atlantic salmon catch, 1987 and 1988, and annual summaries, 1973-1988, for West Newfoundland and South Labrador, Gulf Region. Can. Data Rep. Fish. Aquat. Sci. No. 748, 192 p.

Mullins, C. C. and G. Chaput. MS 1993. The Status of the Atlantic Salmon Stock of Humber River/Bay of Islands, Newfoundland, 1992. DFO Atl. Fish. Res. Doc. 93/34, 53 p.

Mullins, C. C. and G. Chaput. MS 1995. The Status of the Atlantic Salmon Stock of Humber River/Bay of Islands, Newfoundland, 1993. DFO Atl. Fish. Res. Doc. 95/84, 48 p.

Mullins, C. C. and D. G. Reddin. MS 1995. The Status of the Atlantic Salmon Stock of Humber River/Bay of Islands, Newfoundland, 1994. DFO Atl. Fish. Res. Doc. 95/115, 59 p.

Mullins, C. C., J. A. Wright, and R. R. Claytor. MS 1989. Recreational Atlantic salmon catch, 1986 and annual summaries, 1953-1986 for West Newfoundland and South Labrador, Gulf Region. Can. Data Rep. Fish. Aquat. Sci. No. 715, 124 p.

Mullins, C. C., T.R. Porter and J.B. Dempson. MS 1997. The Status of the Atlantic Salmon Stock of Humber River, Newfoundland, 1996. Can. Stock Assessment Secretariat Res. Doc. 97/37, 53 p.

O'Connell, M. F., J. B. Dempson, and R. J. Gibson. MS 1991. Atlantic salmon (Salmo salar L.) smolt production parameter values for fluvial and lacustrine habitats in insular Newfoundland. CAFSAC Res. Doc. 91/19, 11 p.

O'Connell, M. F., D. G. Reddin, and E. G. M. Ash. MS 1995. Status of Atlantic Salmon (*Salmo salar* L.) In Gander River, Notre Dame Bay (SFA 4), Newfoundland, 1994. DFO Atl. Fish. Res. Doc. 95/123, 25 p.

Porter, T. R. and E. M. P. Chadwick. MS 1983. Assessment of Atlantic salmon stocks in statistical areas K and L, western Newfoundland, 1982. CAFSAC Res. Doc. 83/87, 86 p.

Porter, T. R., L. G. Riche, and G. R. Traverse. MS 1974. Catalogue of rivers in Insular Newfoundland Volume C. Data Record Series No. NEW/D-74-9.

Randall, R. G. 1989. Effect of sea-age on the reproductive potential of Atlantic salmon (*Salmo salar*) in eastern Canada. Can. J. Fish. Aquat. Sci. 46: 2210-2218.

Ricker, W. E. 1975. Computation and Interpretation of Biological Statistics of Fish Populations. Bull. Fish. Res. Board Can. 191:382 p.

Sokal, R. R., and F. J. Rohlf. 1969. Biometry. W. H. Freeman and Company, 776 p.

Zale, Alexander V. and Mark B. Bain. 1994. Estimating Tag-Reporting Rates with Postcards as Tag Surrogates. North American Journal of Fisheries Management, Vol. 14, No. 1, pp. 208-211.

Table 1. Equations used in estimation of angling exploitation rate, total catch and total returns of Atlantic salmon in the Humber River in 1997. Parameters in bold type changed value with each iteration of the simulation procedure.

1. EXPLOITATION RATE	=	Tags Recaptured / Tags Available
a. Tags Recaptured	=	Tags Returned / Reporting Rate
Reporting Rate	=	**Tags Returned from Big Falls** / **Tags Recaptured at Big Falls** = 7/11 = 0.6364
b. Tags Available=		Tags Applied x Proportion Tags Retained
Proportion Tags Retained	=	1 - (Tag Loss Rate (TL)) TL = (0.009 tags/day x Median Days to Recapture) **Range of Days to Recapture = 2 to 40 days; Median = 16**
2. CATCH (Small)	=	Adjusted Catch at Big Falls / Proportion of Tags from Big Falls **(Proportion of tags from Big Falls = 15/33 = 0.4545)**
3. RETURNS (Small) (Petersen single census)	=	CATCH (Small) / EXPLOITATION RATE
4. RETURNS (Large)	=	RETURNS (Small) / Prop. Small – RETURNS (Small) **(Prop. Small = 384/451= 0.8514)**

The equations were solved 5000 times to generate the distribution from which confidence limits were determined.

Table 2. Creel survey observations at Big Falls, 1997.
Note: Catches and effort include numbers left on the river after the last survey period of the day. Rod days are adjusted for anglers interviewed more than once.

Week	Anglers Interviewed	Effort		Hours per Angler	Small		Large Released	Total Catch	Hours per Fish
		Rods Days	Hours		Retained	Released			
Retention Fishery									
25	82	89	212	2.6	16	7	1	24	8.82
26	920	1173	3083	3.4	288	215	9	512	6.02
27	1053	1402	4346	4.1	426	225	13	664	6.54
28	650	861	2641	4.1	138	42	1	181	14.59
29	460	569	1793	3.9	93	19	7	119	15.06
30	322	337	1200	3.7	48	33	7	88	13.64
Total	3487	4431	13274	3.8	1009	541	38	1588	8.36
%	96.9	97.3	97.9		100.0	94.3	90.5	97.7	
Release Fishery									
30	6	16	17	2.8	0	2	0	2	8.25
31	75	78	184	2.5	0	24	4	28	6.57
32	18	17	37	2.1	0	5	0	5	7.42
33	11	11	39	3.6	0	2	0	2	19.65
34	0	0	0	0.0	0	0	0	0	.
35	2	2	3	1.3	0	0	0	0	.
36	0	0	0	0.0	0	0	0	0	.
Total	112	124	279	0.0	0	33	4	37	7.55
%	3.1	2.7	2.1		0.0	5.7	9.5	2.3	
Total									
25	82	89	212	2.6	16	7	1	24	8.82
26	920	1173	3083	3.4	288	215	9	512	6.02
27	1053	1402	4346	4.1	426	225	13	664	6.54
28	650	861	2641	4.1	138	42	1	181	14.59
29	460	569	1793	3.9	93	19	7	119	15.06
30	328	353	1217	3.7	48	35	7	90	13.52
31	75	78	184	2.5	0	24	4	28	6.57
32	18	17	37	2.1	0	5	0	5	7.42
33	11	11	39	3.6	0	2	0	2	19.65
34	0	0	0	0.0	0	0	0	0	.
35	2	2	3	1.3	0	0	0	0	.
36	0	0	0	0.0	0	0	0	0	.
Total	3599	4555	13553	3.8	1009	574	42	1625	8.34

Table 3. Creel survey observations at Big Falls, 1991-1997.
Creel surveys were conducted between 0600-2200 hours daily.

Year	Survey Dates	Anglers Interviewed	Hours Fished	Hours per Angler	Small salmon				Large Released	Total Catch	Hours* per Fish	Carlin Tags Observed
					Retained	Released	Total	Prop. Released				
1991	22 Jun.-30 Aug.	726	1600	2.20	136	9	145	0.0621	3	148	10.81	0
1992**	16 Jun.-30 Aug.	607	2628	4.33	738	59	797	.	25	822	.	5
1993	9 Jun.- 20 Aug.	1613	6031	3.74	412	30	442	0.0679	20	462	13.05	2
1994***	19 Jun.-5 Sept.	3839	14219	3.70	765	436	1201	0.3630	63	1264	11.25	14
1995	17 Jun.-5 Sept.	1244	4767	3.83	375	137	512	0.2676	17	529	9.01	23
1996***	18 Jun.-2 Sept.	5331	18867	3.54	1229	782	2011	0.3889	73	2084	9.05	28
1997***	24 Jun.-1 Sept.	3599	13553	3.77	1009	574	1583	0.3626	42	1625	8.34	11

* Hours per Fish based on total catch

** Only anglers with catch interviewed in 1992.

*** 1994,96&97 values represent the entire catch and effort at Big Falls.

Table 4. Proportion of available creel survey periods that were actually surveyed at two fishing locations at Big Falls.

		Fishery														
		Retention					Release					Total				
		PERIOD					PERIOD					PERIOD				
Location	Week	A	B	C	D	Total	A	B	C	D	Total	A	B	C	D	Total
Boat	25	1.00	1.00	1.00	1.00	1.00						1.00	1.00	1.00	1.00	1.00
	26	0.86	0.86	1.00	1.00	0.93						0.86	0.86	1.00	1.00	0.93
	27	0.71	0.71	1.00	1.00	0.86						0.71	0.71	1.00	1.00	0.86
	28	1.00	1.00	1.00	1.00	1.00						1.00	1.00	1.00	1.00	1.00
	29	1.00	1.00	1.00	1.00	1.00						1.00	1.00	1.00	1.00	1.00
	30	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.50	1.00	0.88	1.00	1.00	0.86	1.00	0.96
	31						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	32						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	33						0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
	34						0.00	0.00	0.57	0.57	0.29	0.00	0.00	0.57	0.57	0.29
	35						0.00	0.00	0.33	0.33	0.17	0.00	0.00	0.33	0.33	0.17
	Total	0.91	0.91	1.00	1.00	0.96	0.58	0.58	0.72	0.75	0.66	0.74	0.74	0.86	0.87	0.80
Stair	25	1.00	1.00	1.00	1.00	1.00						1.00	1.00	1.00	1.00	1.00
	26	1.00	1.00	0.86	0.86	0.93						1.00	1.00	0.86	0.86	0.93
	27	1.00	0.86	1.00	1.00	0.96						1.00	0.86	1.00	1.00	0.96
	28	0.86	1.00	1.00	1.00	0.96						0.86	1.00	1.00	1.00	0.96
	29	1.00	1.00	1.00	1.00	1.00						1.00	1.00	1.00	1.00	1.00
	30	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	31						0.86	0.86	1.00	1.00	0.93	0.86	0.86	1.00	1.00	0.93
	32						0.86	0.86	1.00	1.00	0.93	0.86	0.86	1.00	1.00	0.93
	33						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	34						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	35						0.83	0.83	0.67	0.67	0.75	0.83	0.83	0.67	0.67	0.75
	Total	0.97	0.97	0.97	0.97	0.97	0.92	0.92	0.94	0.94	0.93	0.94	0.94	0.96	0.96	0.95
Total	25	1.00	1.00	1.00	1.00	1.00						1.00	1.00	1.00	1.00	1.00
	26	0.93	0.93	0.93	0.93	0.93						0.93	0.93	0.93	0.93	0.93
	27	0.86	0.79	1.00	1.00	0.91						0.86	0.79	1.00	1.00	0.91
	28	0.93	1.00	1.00	1.00	0.98						0.93	1.00	1.00	1.00	0.98
	29	1.00	1.00	1.00	1.00	1.00						1.00	1.00	1.00	1.00	1.00
	30	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.75	1.00	0.94	1.00	1.00	0.93	1.00	0.98
	31						0.93	0.93	1.00	1.00	0.96	0.93	0.93	1.00	1.00	0.96
	32						0.93	0.93	1.00	1.00	0.96	0.93	0.93	1.00	1.00	0.96
	33						0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
	34						0.50	0.50	0.79	0.79	0.64	0.50	0.50	0.79	0.79	0.64
	35						0.42	0.42	0.50	0.50	0.46	0.42	0.42	0.50	0.50	0.46
	Total	0.94	0.94	0.99	0.99	0.96	0.75	0.75	0.83	0.85	0.80	0.84	0.84	0.91	0.91	0.88

Table 5. Adjusted retained catch of small salmon at two creel survey locations at Big Falls, 1997.
Adjustments are based on the proportion of available survey periods actually covered in the Creel survey.
Small Retained

		Fishery														
		Retention					Release					Total				
		PERIOD					PERIOD					PERIOD				
Location	Week	A	B	C	D	Total	A	B	C	D	Total	A	B	C	D	Total
Boat	25	4	3	1	8	16						4	3	1	8	16
	26	83	76	41	54	254						83	76	41	54	254
	27	97	153	27	74	350						97	153	27	74	350
	28	32	28	1	22	83						32	28	1	22	83
	29	8	13	5	27	53						8	13	5	27	53
	30	5	7	5	12	29	0	0	0	0	0	5	7	5	12	29
	31						0	0	0	0	0	0	0	0	0	0
	32						0	0	0	0	0	0	0	0	0	0
	33						0	0	0	0	0	0	0	0	0	0
	34						0	0	0	0	0	0	0	0	0	0
	35						0	0	0	0	0	0	0	0	0	0
	Total	228	279	80	197	785	0	0	0	0	0	228	279	80	197	785
Stair	25	0	0	0	0	0						0	0	0	0	0
	26	17	21	8	14	60						17	21	8	14	60
	27	27	40	18	68	153						27	40	18	68	153
	28	5	9	8	34	56						5	9	8	34	56
	29	9	11	4	16	40						9	11	4	16	40
	30	3	7	1	8	19	0	0	0	0	0	3	7	1	8	19
	31						0	0	0	0	0	0	0	0	0	0
	32						0	0	0	0	0	0	0	0	0	0
	33						0	0	0	0	0	0	0	0	0	0
	34						0	0	0	0	0	0	0	0	0	0
	35						0	0	0	0	0	0	0	0	0	0
	Total	61	88	39	140	328	0	0	0	0	0	61	88	39	140	328
Total	25	4	3	1	8	16	0	0	0	0	0	4	3	1	8	16
	26	100	97	49	68	314	0	0	0	0	0	100	97	49	68	314
	27	124	192	45	142	503	0	0	0	0	0	124	192	45	142	503
	28	37	37	9	56	139	0	0	0	0	0	37	37	9	56	139
	29	17	24	9	43	93	0	0	0	0	0	17	24	9	43	93
	30	8	14	6	20	48	0	0	0	0	0	8	14	6	20	48
	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	289	367	119	337	1112	0	0	0	0	0	289	367	119	337	1112

Table 6. Adjusted released catch of small salmon at two creel survey locations at Big Falls, 1997. Adjustments are based on the proportion of available survey periods actually covered in the Creel survey.

Small Released

		Fishery														
		Retention					Release					Total				
		PERIOD					PERIOD					PERIOD				
Location	Week	A	B	C	D	Total	A	B	C	D	Total	A	B	C	D	Total
Boat	25	2	4	1	0	7						2	4	1	0	7
	26	55	82	15	42	194						55	82	15	42	194
	27	35	140	24	21	220						35	140	24	21	220
	28	4	11	1	7	23						4	11	1	7	23
	29	0	2	0	4	6						0	2	0	4	6
	30	0	4	0	6	10	0	0	0	0	0	0	4	0	6	10
	31						3	6	1	2	12	3	6	1	2	12
	32						0	3	0	2	5	0	3	0	2	5
	33						0	3	0	0	3	0	3	0	0	3
	34								0	0	0	0	0	0	0	0
	35								0	0	0	0	0	0	0	0
	Total	96	243	41	80	460	3	12	1	4	20	99	254	42	84	479
Stair	25	0	0	0	0	0						0	0	0	0	0
	26	11	7	5	22	45						11	7	5	22	45
	27	8	20	13	17	58						8	20	13	17	58
	28	1	7	3	8	19						1	7	3	8	19
	29	1	0	1	11	13						1	0	1	11	13
	30	0	1	1	21	23	0	0	0	2	2	0	1	1	23	25
	31						1	1	0	10	12	1	1	0	10	12
	32						0	0	0	0	0	0	0	0	0	0
	33						0	0	0	0	0	0	0	0	0	0
	34						0	0	0	0	0	0	0	0	0	0
	35						0	0	0	0	0	0	0	0	0	0
	Total	21	35	23	79	158	1	1	0	12	14	22	36	23	91	172
Total	25	2	4	1	0	7	0	0	0	0	0	2	4	1	0	7
	26	66	89	20	64	238	0	0	0	0	0	66	89	20	64	238
	27	43	160	37	38	278	0	0	0	0	0	43	160	37	38	278
	28	5	18	4	15	42	0	0	0	0	0	5	18	4	15	42
	29	1	2	1	15	19	0	0	0	0	0	1	2	1	15	19
	30	0	5	1	27	33	0	0	0	2	2	0	5	1	29	35
	31	0	0	0	0	0	4	7	1	12	24	4	7	1	12	24
	32	0	0	0	0	0	0	3	0	2	5	0	3	0	2	5
	33	0	0	0	0	0	0	3	0	0	3	0	3	0	0	3
	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	117	278	64	159	617	4	13	1	16	34	121	290	65	175	651

Table 7. Adjusted released catch of large salmon at two creel survey locations at B g Falls, 1997.
Adjustments are based on the proportion of available survey periods actually covered in the Creel survey.

Large Released

		Fishery														
		Retention					Release					Total				
		PERIOD					PERIOD					PERIOD				
Location	Week	A	B	C	D	Total	A	B	C	D	Total	A	B	C	D	Total
Boat	25	0	0	1	0	1						0	0	1	0	1
	26	7	2	0	1	10						7	2	0	1	10
	27	1	10	0	0	11						1	10	0	0	11
	28	0	1	0	0	1						0	1	0	0	1
	29	0	0	0	5	5						0	0	0	5	5
	30	0	1	0	5	6	0	0	0	0	0	0	1	0	5	6
	31						1	1	0	1	3	1	1	0	1	3
	32						0	0	0	0	0	0	0	0	0	0
	33						0	0	0	0	0	0	0	0	0	0
	34								0	0	0	0	0	0	0	0
	35								0	0	0	0	0	0	0	0
		8	14	1	11	35	1	1	0	1	3	9	15	1	12	38
Stair	25	0	0	0	0	0						0	0	0	0	0
	26	0	0	0	0	0						0	0	0	0	0
	27	1	2	0	2	5						1	2	0	2	5
	28	0	0	0	0	0						0	0	0	0	0
	29	0	2	0	0	2						0	2	0	0	2
	30	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1
	31						1	0	0	0	1	1	0	0	0	1
	32						0	0	0	0	0	0	0	0	0	0
	33						0	0	0	0	0	0	0	0	0	0
	34						0	0	0	0	0	0	0	0	0	0
	35						0	0	0	0	0	0	0	0	0	0
		1	5	0	2	8	1	0	0	0	1	2	5	0	2	10
Total	25	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1
	26	7	2	0	1	10	0	0	0	0	0	7	2	0	1	10
	27	2	12	0	2	17	0	0	0	0	0	2	12	0	2	17
	28	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1
	29	0	2	0	5	7	0	0	0	0	0	0	2	0	5	7
	30	0	2	0	5	7	0	0	0	0	0	0	2	0	5	7
	31	0	0	0	0	0	2	1	0	1	4	2	1	0	1	4
	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		9	19	1	13	43	2	1	0	1	4	12	20	1	14	47

Table 8. Number of bright Atlantic salmon captured in Humber River tagging traps, 1989-1997.

Year	Lower Estuary Trap			Upper Estuary Trap			Total			Prop.	Prop.
	Small	Large	Total	Small	Large	Total	Small	Large	Total	Small	Large
1989	2	5	7	.	.	.	2	5	7	.	.
1990	257	22	279	.	.	.	257	22	279	0.9211	0.0789
1991	104	4	108	.	.	.	104	4	108	0.9630	0.0370
1992	181	29	210	.	.	.	181	29	210	0.8619	0.1381
1993	699	45	744	244	11	255	943	56	999	0.9439	0.0561
1994*	438	79	517	187	3	190	625	82	707	0.8840	0.1160
1995	844	104	948	1115	39	1154	1959	143	2102	0.9320	0.0680
1996	516	63	579	461	23	484	977	86	1063	0.9191	0.0809
1997	248	47	295	136	20	156	384	67	451	0.8514	0.1486
Mean (92-96)	536	64	600	.	.	.	937	79	1016	0.9221	0.0918

* Upper trap fished 10 km upstream.

Table 9. Number and condition of small and large salmon captured in the two tagging traps in 1997.
Note: Week refers to week of tagging.

		Large Kelt		Large Brights				Small Kelt			Small Brights				
		Tagged	ALL	Injured	Mortality	Tagged	ALL	Mortality	Tagged	ALL	Injured	Mortality	Tagged	ALL	ALL
TRAP	WEEK														
1	23	.	.	.	.	5	5	.	1	1	.	.	1	1	7
	24	2	2	1	.	22	23	.	31	31	.	.	61	61	117
	25	3	3	1	.	7	8	.	24	24	4	.	86	90	125
	26	.	.	.	.	4	4	.	7	7	1	.	57	58	69
	27	.	.	.	.	2	2	.	.	.	.	4	19	23	25
	28	.	.	.	.	.	.	.	.	.	.	.	2	2	2
	29	.	.	.	.	.	.	.	.	.	.	.	2	2	2
	30	.	.	.	.	5	5	.	.	.	1	.	5	6	11
	31	.	.	.	.	.	.	.	.	.	.	.	5	5	5
	ALL	5	5	2	.	45	47	.	63	63	6	4	238	248	363
2	WEEK														
	23	2	2	.	.	.	.	.	9	9	.	.	.	.	11
	24	2	2	.	1	9	10	.	35	35	.	.	38	38	85
	25	.	.	1	.	8	9	1	9	10	.	.	71	71	90
	26	.	.	.	.	.	.	.	.	.	.	.	1	1	1
	27	.	.	.	.	.	.	.	.	.	.	.	20	20	20
	28	.	.	.	.	.	.	.	.	.	.	.	2	2	2
	29	.	.	.	.	1	1	.	.	.	.	.	1	1	2
	30	.	.	.	.	.	.	.	.	.	.	.	3	3	3
	ALL	4	4	1	1	18	20	1	53	54	.	.	136	136	214
ALL	WEEK														
	23	2	2	.	.	5	5	.	10	10	.	.	1	1	18
	24	4	4	1	1	31	33	.	66	66	.	.	99	99	202
	25	3	3	2	.	15	17	1	33	34	4	.	157	161	215
	26	.	.	.	.	4	4	.	7	7	1	.	58	59	70
	27	.	.	.	.	2	2	.	.	.	.	4	39	43	45
	28	.	.	.	.	.	.	.	.	.	.	.	4	4	4
	29	.	.	.	.	1	1	.	.	.	.	.	3	3	4
	30	.	.	.	.	5	5	.	.	.	1	.	8	9	14
	31	.	.	.	.	.	.	.	.	.	.	.	5	5	5
	ALL	9	9	3	1	63	67	1	116	117	6	4	374	384	577

Table 10. Recapture week and location of small salmon on Humber River in 1997.
Note: Week refers to week of recapture.

	RECAPTURE LOCATION							
	Humber River	Deer Lake	Little Falls	Big Falls	Adies Stream	Harrimans Steady	Taylors Brook	ALL
GEAR WEEK								
Retained	1	.	.	.	.	1	.	2
26	.	.	1	3	.	2	.	6
27	.	.	6	8	.	1	.	15
28	.	.	1	3	.	2	.	6
29	.	.	.	.	.	.	1	1
30	.	1	.	.	1	.	.	2
ALL	1	1	8	14	1	6	1	32
Released WEEK								
w Tag 31	.	.	.	.	.	.	1	1
ALL	.	.	.	.	.	.	1	1
Released WEEK								
wo Tag .	1	.	.	.	.	.	.	1
27	.	.	.	1	.	.	.	1
31	.	1	.	.	.	.	.	1
ALL	1	1	.	1	.	.	.	3
Unknown WEEK								
.	.	.	.	1	.	.	.	1
ALL	.	.	.	1	.	.	.	1
ALL	2	2	8	16	1	6	2	37

Table 11. Tagged small Atlantic salmon observed and reported at Big Falls, 1997.

Tag Number	Fork Length (cm)	Date Tagged	Date Recaptured	No. Days at Large	Tags Observed by Creel Survey Clerks	
					Observed	Returned
Angled-Released wo tag						
3562	61.3	11 June	5 July	24	*	*
Angled-Retained						
4762	55.8	17 June	27 June	10	*	*
4766	51.5	17 June	9 July	22		
4768	56.8	17 June	11 July	24	*	*
4777	55.5	17 June	7 July	20		
4790	54.8	17 June	2 July	15		
4805	55.3	17 June	2 July	15		
4812	54.3	17 June	12 July	25		
4823	50.5	17 June	7 July	20		
4861	52.8	17 June	27 June	10	*	*
4862	56.4	17 June			*	
4877	54.3	17 June	29 June	12		
4885	52.8	17 June	2 July	15		
4889	53.7	17 June	3 July	16	*	*
5009	56.4	20 June			*	*
5088	56.8	23 June	3 July	16	*	*
5120	55.2	25 June	2 July	15		
5143	52.3	27 June			*	
Angled-Unknown Ret./Rel.						
4873	57.2	17 June			*	
4992	58.1	20 June			*	
Total					11	7
Tag Reporting Rate						0.6364

Table 12. Estimation of angling exploitation rate for retained small salmon based on tags available from the two tagging traps in 1997. Adjustments are made for tag loss and reporting rate.

Week Tagged	No. Small Tagged* (X1)	Median Days to Recapture (X2)	Proportion of Tags Retained (X3=1-(X2*0.009))	Adjusted Tags Available (X4=X1*X3)	Tags Returned (Ret) (X5)	Tag Reporting Rate (X6)	Adjusted Tags Recaptured (X7=X5/X6)	Adjusted Angling ER (X8=X7/X4)
23	1	.	1.000	1	.	.	.	.
24	99	16	0.856	85	16	0.6364	25	0.2941
25	157	16	0.856	134	11	0.6364	17	0.1269
26	58	7	0.937	54	3	0.6364	5	0.0926
27	39	5	0.955	37	3	0.6364	5	0.1351
28	4		1.000	4	.	.	.	.
29	3		1.000	3	.	.	.	.
30	8		1.000	8	.	.	.	.
Overall	369	16	0.856	316	33	0.6364	52	0.1646

* Not adjusted for tags destined for Hughes Brook.

Table 13. Estimated total catch of retained small Atlantic salmon on the Humber River, 1997. Numbers in parentheses are estimated 95% confidence limits.

SMALL CATCH (Ret.) = $\frac{\textbf{Adjusted Catch at Big Falls}}{\textbf{Prop. Humber Catch from Big Falls}}$

= $\frac{1112}{0.4545}$

= **2,447** (1,748 – 3,670)

Where:

Prop. Humber Catch taken at Big Falls = $\frac{\text{Big Falls Tags (Retained Small)}}{\text{Humber Tags (Retained Small)}} = \frac{15}{33} = 0.4545$

Table 14. Estimated returns and spawning escapement of Atlantic salmon on the Humber River, 1997.

ESTIMATED PARAMETERS:	Parameter Value	95% C.I. Lower	95% C.I. Upper
Tags Recaptured (R)*	52	36	91
Tags Available to Retention Fishery (M)**	316	299	334
Estimated Exploitation on Small salmon (*er*)	0.1646	0.1204	0.2725
Estimated Total Small Retained (C)	2,447	1,748	3,670
Proportion Small Retained	0.6307		
Total Small Released	1,433	1,024	2,149
Total Large Released	133		
Assumed catch & release mortality rate	10%		
Proportion Small in Population	0.8514	0.8180	0.8820
RETURNS:			
(Petersen - single census estimate (95% CI's for small are from Ricker, 1975))			
SMALL	14,866	11,340	19,501
LARGE	2,595	2,523	4,339
TOTAL	17,461	13,863	23,840
POTENTIAL SPAWNERS:			
(adjusted for catch & release mortality)			
SMALL	12,276	8,750	16,911
LARGE	2,582	2,510	4,326
TOTAL	14,857	11,259	21,237

* Adjusted for mean reporting rate of 0.6364

** Adjusted for tag loss based on 0.009 tags/day.

Table 15. Estimation of the percentage of the conservation egg deposition requirement achieved in the Humber River, 1997.

Habitat:

Fluvial Rearing Units (100 sq. m):		115,307 units	(Porter and Chadwick, MS 1983)
Lacustrine Area:		1,751 ha	(Mullins and Chaput, MS 1994)

Minimum Egg Deposition Rate:

Fluvial	240 eggs per Rearing Unit
Lacustrine	368 eggs per ha of Lacustrine Area

Biological Characteristics, 1997:

Fecundity:		1,540 eggs / kg	
Small:	% overall	85.1	(tagging trap, 1997)
(<63 cm)	% female	59.6 (n=114)	(recreational, 1997)
	mean wt females	2.0 kg (n=34)	(recreational, 1997)
Large:	% overall	14.9	(tagging trap, 1997)
(>=63 cm)	% female	68.6	(commercial, 1991)
	mean wt females	3.7 + kg	(Porter and Chadwick, MS 1983)

Percent Conservation Egg Deposition Achieved, 1997:

= potential egg depositions / minimum conservation requirement X 100

$$= \frac{\text{small spawners x (eggs per small spawner) + large spawners x (eggs per large spawner)}}{\text{(Rearing Units x 240 eggs / unit) + (Lacustrine Area x 368 eggs / ha)}} \times 100$$

Where:

Eggs per Small Spawner = (.596 * 2.0 * 1,540)
= 1,836

Eggs per Large Spawner = (.686 * 3.7 * 1,540)
= 3,909

$$= \frac{\text{small spawners x } 1{,}836 \quad \text{large spawners x } 3{,}909}{28{,}318{,}048} \times 100$$

Where:

		Petersen (single census)
Small Spawners	=	12,276
Large Spawners	=	2,582
Total	=	14,857

= 115% (95% CI = 91% - 169%)

Table 16. Summary of Atlantic salmon spawning escapement and the percentage of the conservation egg deposition requirement achieved on the Humber River, 1990-1997. Catch is based on creel survey results.
Conservation egg deposition requirement: 28.3 million eggs

	Estimated Returns			Angling Catch			Spawning Escapement*			% Egg Requirement
				Small		Large				
Year	Small	Large	Total	Retained	Released	Released	Small	Large	Total	Achieved**
1990	12,216	855	13,071	3,054	.	75	9,162	848	10,010	60
1991	5,724	401	6,125	1,431	.	11	4,293	400	4,693	27
1992	17,571	2,945	20,516	4,349	317	177	13,191	2,927	16,118	117
1993	18,477	636	19,113	4,161	303	125	14,286	624	14,909	96
1994	7,995	1,030	9,025	2,523	1,438	166	5,328	1,013	6,342	40
1995	27,898	2,064	29,963	5,150	1,881	233	22,560	2,041	24,601	128
1996	30,445	2,679	33,125	4,740	3,016	237	25,404	2,655	28,059	186
1997	14,866	2,595	17,461	2,447	1,433	133	12,276	2,582	14,857	115
Mean (92-96)	20,477	1,871	22,348	4,185	1,391	188	16,154	1,852	18,006	113

* Spawning escapements are adjusted from previous reports to account for 10% mortality on released fish.
** Percentage egg requirement achieved in 1990 is based on biological characteristics from Porter and Chadwick, 1983.

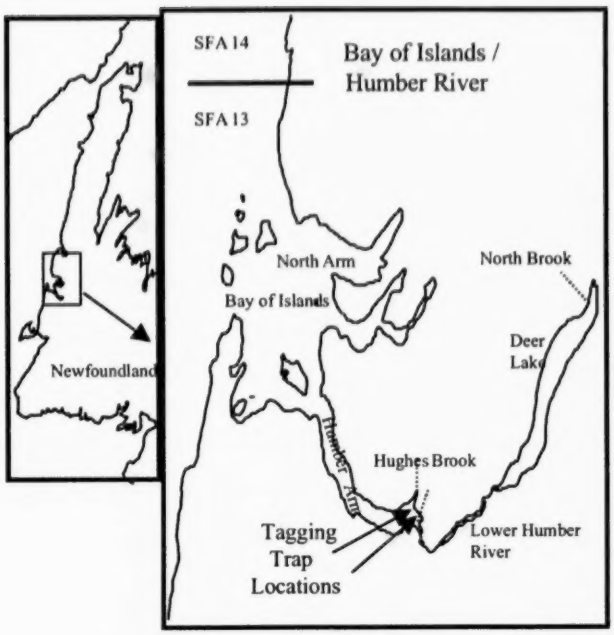


Figure 1. Location of Atlantic salmon tagging traps operated in the estuary of the Humber River in 1997.

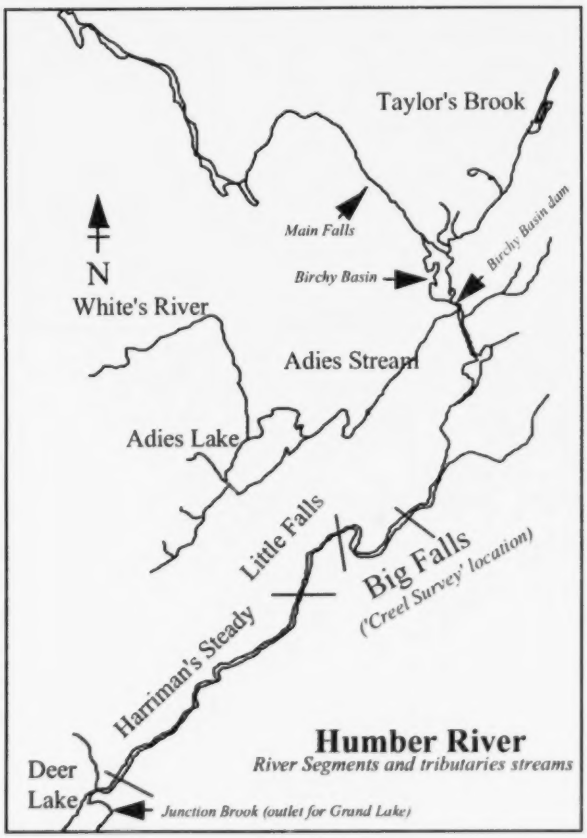


Figure 2. River segments of the Humber River, upstream of Deer Lake and showing the Big Falls Creel Survey location.

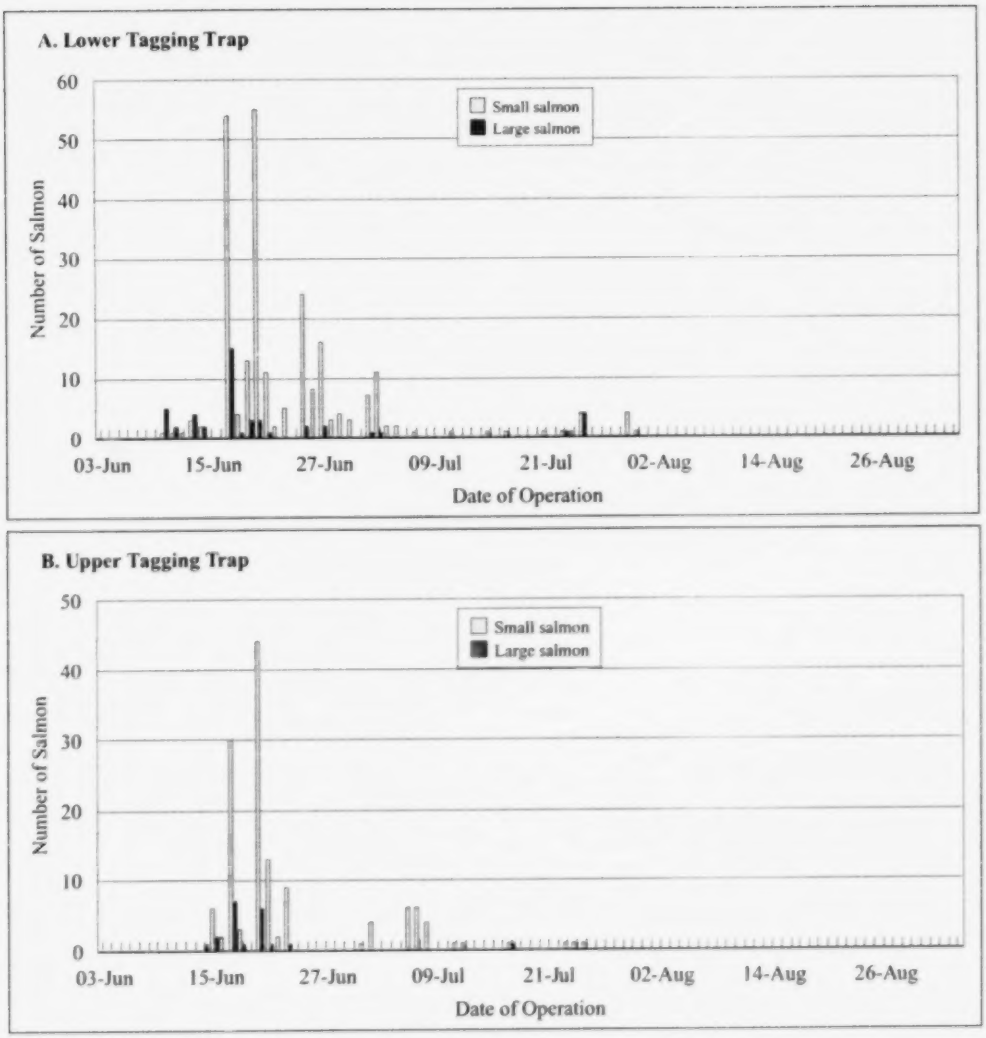
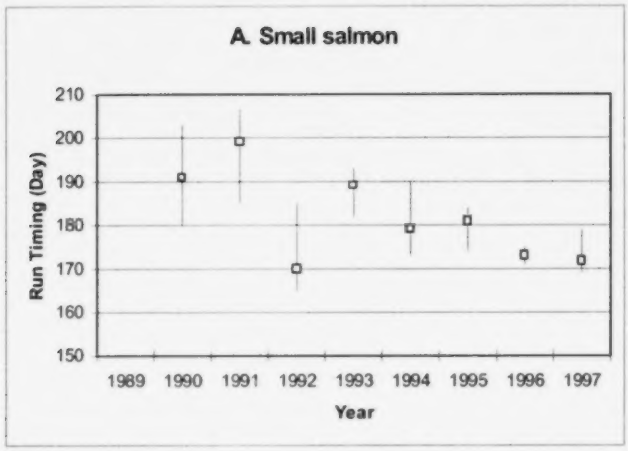


Figure 3. Distribution of counts of small and large salmon caught in the Lower and Upper tagging traps in 1997.



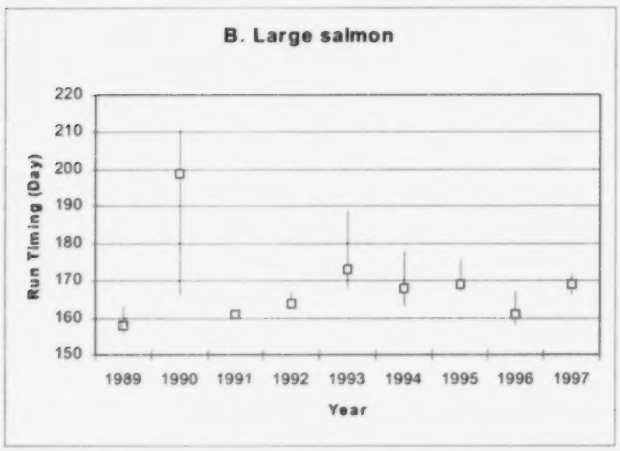


Figure 4. Run timing of small and large Atlantic salmon at the Lower tagging trap on the Humber River, 1989-97. Symbols represent the 25, 50 and 75 percent of the run for each year.

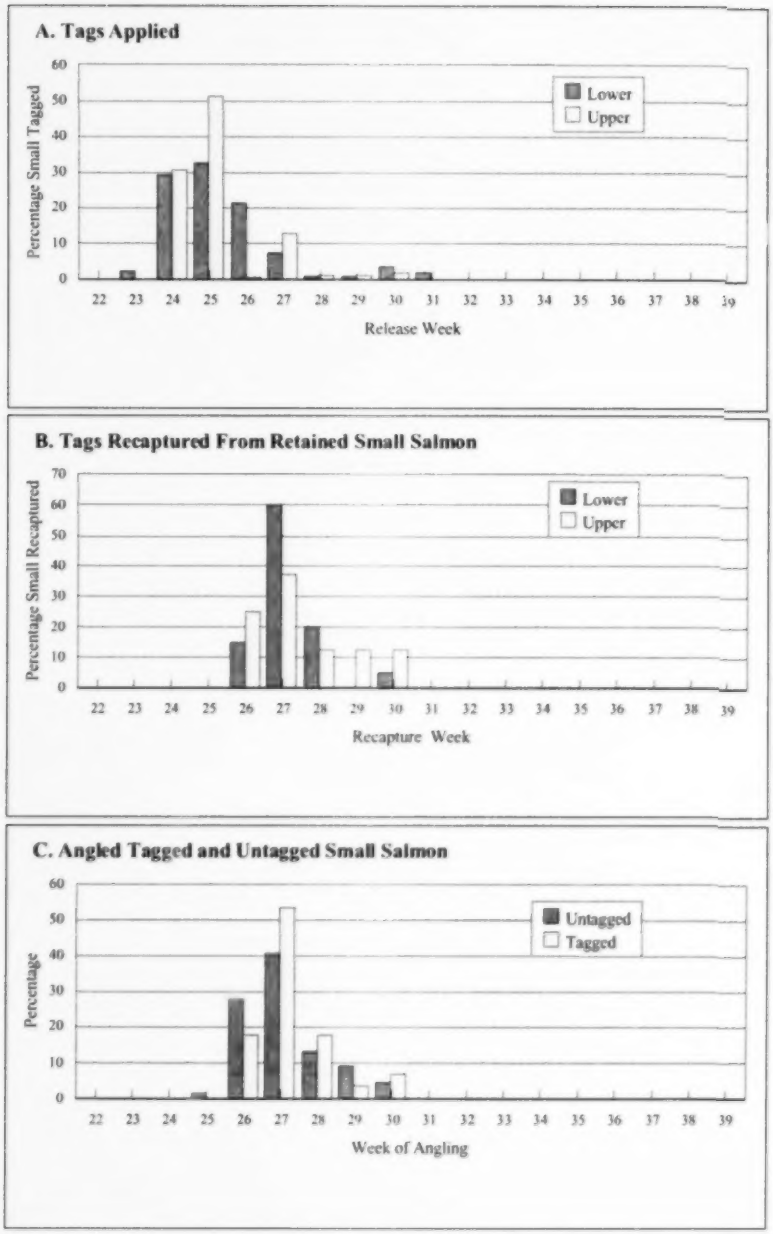


Figure 5. Weekly distribution of tag applications and recaptures in angling of tagged and untagged retained small salmon on the Humber River in 1997.

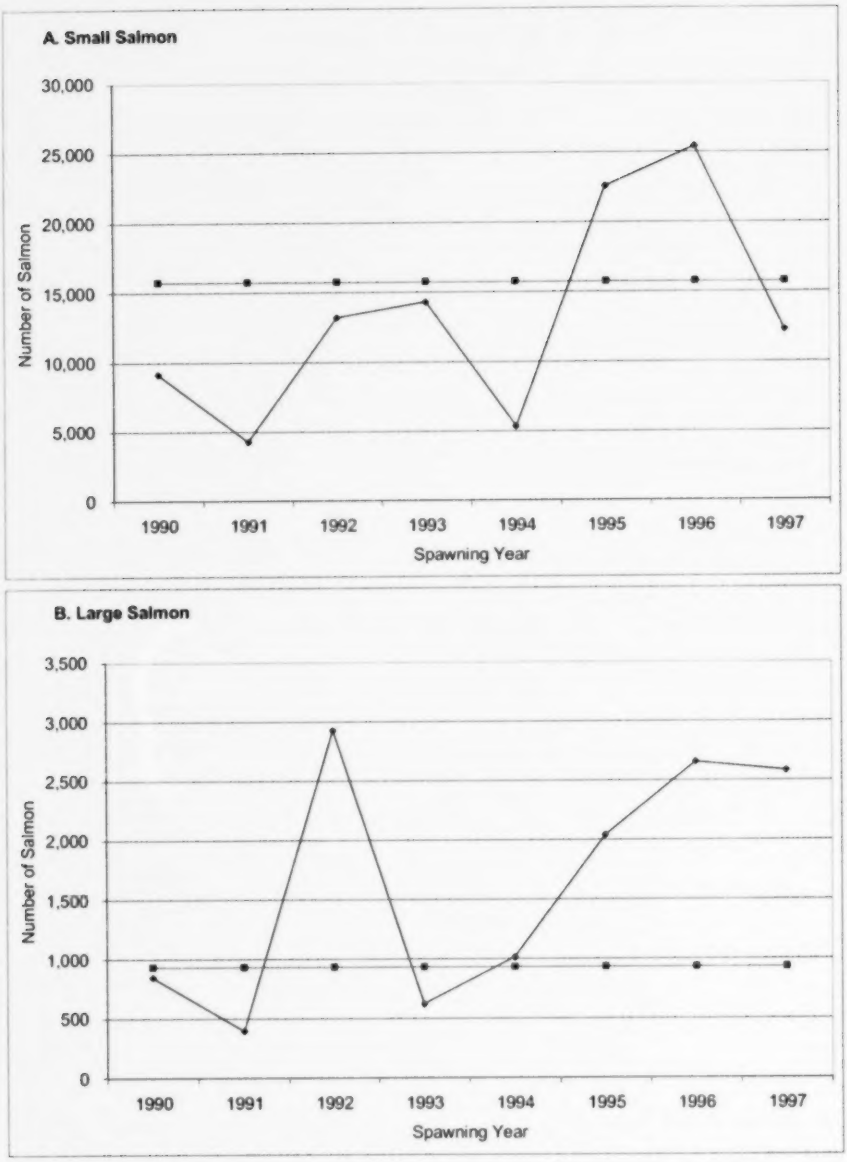


Figure 6. Estimated small and large Atlantic salmon spawners on the Humber River. Horizontal lines represent the estimated conservation spawner requirements.

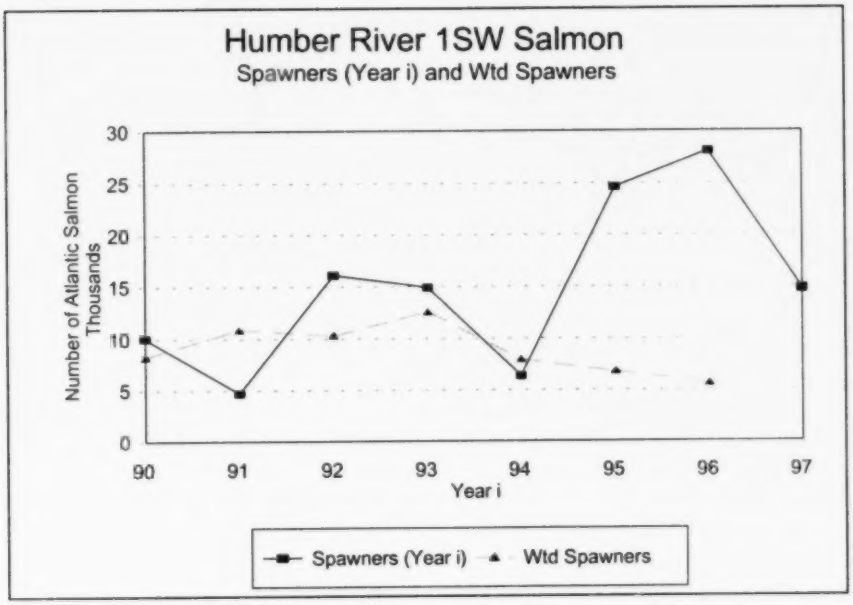


Figure 7. Relationship between total spawners in Year i and spawner recruits adjusted for year-class (wtd spawners).

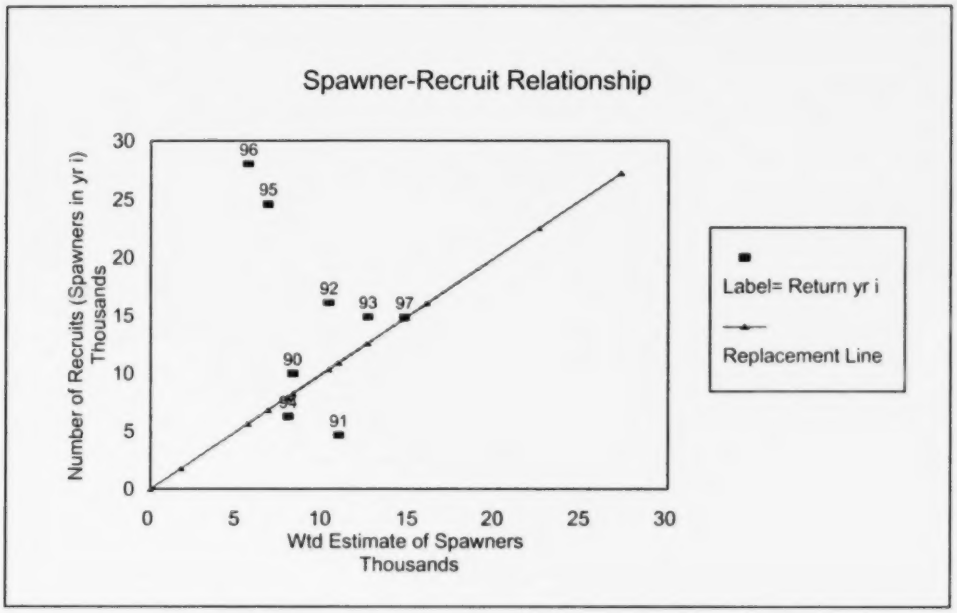


Figure 8. Relationship between 1SW salmon spawners and recruits on the Humber River.

Appendix 1. Mean fork length, weight and sex composition of small and large female Atlantic salmon of the Humber River, 1988-1996. Sex is determined from internal examination.

Angling

		FORK LENGTH (cm)					WHOLE WEIGHT FEMALES (kg)					NO.	PERCENT FEMALE	
		N	MEAN	MIN	MAX	STD	N	MEAN	MIN	MAX	STD	SEXED	N	%
Large	YY													
	88	1	63.2	63.2	63.2	.	0	.	.	.	.	0	0	.
	90	1	63.5	63.5	63.5	.	0	.	.	.	.	1	1	100.0
	92	3	63.0	63.0	63.0	0.0	1	2.7	2.7	2.7	.	2	1	50.0
	93	1	63.0	63.0	63.0	.	1	2.4	2.4	2.4	.	1	1	100.0
	94	3	63.0	63.0	63.0	0.0	0	.	.	.	.	0	0	.
	96	6	69.7	63.0	93.5	12.2	2	2.2	2.0	2.3	0.2	5	3	60.0
	97	4	63.3	63.0	64.0	0.5	0	.	.	.	.	2	0	.
	1984-91	2	63.4	63.2	63.5	0.2	0	.	.	.	.	1	1	100.0
	1992-96	13	66.1	63.0	93.5	8.6	4	2.4	2.0	2.7	0.3	8	5	62.5
	Total	19	65.2	63.0	93.5	7.2	4	2.4	2.0	2.7	0.3	11	6	54.5
Small	YY													
	88	72	55.7	48.0	62.0	3.0	0	.	.	.	.	0	0	.
	89	149	54.3	43.3	62.0	3.0	9	1.4	1.0	1.8	0.3	86	37	43.0
	90	54	56.4	49.0	62.5	3.3	0	.	.	.	.	27	19	70.4
	91	164	54.3	45.7	62.0	2.7	65	1.6	1.2	2.5	0.2	130	66	50.8
	92	357	56.1	48.5	62.5	2.6	57	1.9	1.5	2.5	0.3	254	138	54.3
	93	127	55.6	48.0	62.5	2.9	49	1.7	1.0	2.4	0.3	83	56	67.5
	94	372	55.6	48.0	62.8	2.9	21	1.7	1.3	2.4	0.3	112	57	50.9
	95	119	55.5	48.0	62.0	2.7	18	1.6	1.2	1.9	0.2	73	37	50.7
	96	294	55.6	47.0	62.5	2.7	109	1.8	1.1	2.8	0.3	187	112	59.9
	97	173	56.8	47.0	62.5	2.8	34	2.0	1.1	3.0	0.4	114	68	59.6
	1984-91	439	54.8	43.3	62.5	3.0	74	1.6	1.0	2.5	0.2	243	122	50.2
	1992-96	1269	55.7	47.0	62.8	2.8	254	1.8	1.0	2.8	0.3	709	400	56.4
	Total	1881	55.6	43.3	62.8	2.9	362	1.8	1.0	3.0	0.3	1066	590	55.3

Appendix 2. Mean fork length, weight and sex composition of small and large female Atlantic salmon of the Humber River, 1988-1996. Sex is determined from internal examination.

Tagging Traps

		FORK LENGTH (cm)					WHOLE WEIGHT FEMALES (kg)					NO.	PERCENT FEMALE	
		N	MEAN	MIN	MAX	STD	N	MEAN	MIN	MAX	STD	SEXED	N	%
Large	YY													
	89	5	75.6	71.5	77.5	2.4	0	.	.	.	.	5	5	100.0
	90	22	72.6	63.0	92.0	8.3	0	.	.	.	.	0	0	.
	91	4	77.5	75.5	80.0	2.1	0	.	.	.	.	0	0	.
	92	29	75.2	63.6	91.0	5.2	0	.	.	.	.	0	0	.
	93	56	72.6	63.2	90.6	6.0	1	5.0	5.0	5.0	.	1	1	100.0
	94	82	74.1	63.0	88.5	5.8	0	.	.	.	.	0	0	.
	95	143	75.8	63.1	115.0	5.9	0	.	.	.	.	0	0	.
	96	86	75.8	63.5	93.1	6.3	0	.	.	.	.	0	0	.
	97	73	75.5	63.5	89.2	5.3	0	.	.	.	.	0	0	.
	1984-91	31	73.7	63.0	92.0	7.3	0	.	.	.	.	5	5	100.0
	1992-96	396	74.9	63.0	115.0	6.0	1	5.0	5.0	5.0	.	1	1	100.0
	Total	500	75.0	63.0	115.0	6.0	1	5.0	5.0	5.0	.	6	6	100.0
Small	YY													
	89	2	52.5	51.4	53.5	1.5	0	.	.	.	.	0	0	.
	90	255	54.7	43.9	62.8	3.7	0	.	.	.	.	29	21	72.4
	91	102	52.3	37.3	61.3	3.5	24	1.3	0.9	1.9	0.2	39	27	69.2
	92	181	53.7	34.7	62.0	3.3	14	1.8	1.0	2.8	0.5	22	17	77.3
	93	937	53.4	38.3	62.6	2.9	37	1.4	1.0	2.6	0.3	59	40	67.8
	94	624	53.2	44.0	62.8	2.8	4	2.0	1.5	2.3	0.4	9	4	44.4
	95	1958	52.9	39.4	62.9	2.6	0	.	.	.	.	5	3	60.0
	96	977	53.4	40.0	62.8	2.8	3	2.2	1.8	2.7	0.5	5	3	60.0
	97	404	54.5	45.7	62.7	2.8	0	.	.	.	.	0	0	.
	1984-91	359	54.0	37.3	62.8	3.8	24	1.3	0.9	1.9	0.2	68	48	70.6
	1992-96	4677	53.2	34.7	62.9	2.8	58	1.6	1.0	2.8	0.4	100	67	67.0
	Total	5440	53.3	34.7	62.9	2.9	82	1.5	0.9	2.8	0.4	168	115	68.5

Appendix 3. Smolt-age distribution of small and large Atlantic salmon of the Humber River. Virgin spawners only.

Angling

		SMOLT-AGE												Total		
		2			3			4			5					
		N	%	MEAN	N	%	MEAN	N	%	MEAN	N	%	MEAN	N	%	MEAN
Large	YY															
	88	.	.	.	1	100.0	3.0	.	.	.	.	.	.	1	100.0	3.0
	90	.	.	.	1	100.0	3.0	.	.	.	.	.	.	1	100.0	3.0
	92	.	.	.	2	66.7	3.0	1	33.3	4.0	.	.	.	3	100.0	3.3
	94	.	.	.	2	66.7	3.0	1	33.3	4.0	.	.	.	3	100.0	3.3
	96	.	.	.	3	100.0	3.0	.	.	.	.	.	.	3	100.0	3.0
	97	.	.	.	1	33.3	3.0	2	66.7	4.0	.	.	.	3	100.0	3.7
	1984-91	.	.	.	2	100.0	3.0	.	.	.	.	.	.	2	100.0	3.0
	1992-96	.	.	.	7	77.8	3.0	2	22.2	4.0	.	.	.	9	100.0	3.2
	Total	.	.	.	10	71.4	3.0	4	28.6	4.0	.	.	.	14	100.0	3.3
Small	YY															
	88	2	2.6	2.0	48	62.3	3.0	27	35.1	4.0	.	.	.	77	100.0	3.3
	89	7	5.6	2.0	95	75.4	3.0	23	18.3	4.0	1	0.8	5.0	126	100.0	3.1
	90	2	3.6	2.0	32	58.2	3.0	21	38.2	4.0	.	.	.	55	100.0	3.3
	91	10	6.0	2.0	132	78.6	3.0	26	15.5	4.0	.	.	.	168	100.0	3.1
	92	9	2.6	2.0	282	82.7	3.0	50	14.7	4.0	.	.	.	341	100.0	3.1
	93	2	1.6	2.0	97	75.2	3.0	30	23.3	4.0	.	.	.	129	100.0	3.2
	94	4	1.2	2.0	183	55.6	3.0	141	42.9	4.0	1	0.3	5.0	329	100.0	3.4
	95	.	.	.	60	54.5	3.0	50	45.5	4.0	.	.	.	110	100.0	3.5
	96	.	.	.	145	50.7	3.0	133	46.5	4.0	8	2.8	5.0	286	100.0	3.5
	97	2	1.2	2.0	124	74.3	3.0	38	22.8	4.0	3	1.8	5.0	167	100.0	3.3
	1984-91	21	4.9	2.0	307	72.1	3.0	97	22.8	4.0	1	0.2	5.0	426	100.0	3.2
	1992-96	15	1.3	2.0	767	64.2	3.0	404	33.8	4.0	9	0.8	5.0	1195	100.0	3.3
	Total	38	2.1	2.0	1198	67.0	3.0	539	30.1	4.0	13	0.7	5.0	1788	100.0	3.3

Appendix 4. Smolt-age distribution of small and large Atlantic salmon of the Humber River.
Virgin spawners only.

Tagging Traps

		SMOLT-AGE															Total		
		2			3			4			5			6					
		N	%	MEAN	N	%	MEAN	N	%	MEAN	N	%	MEAN	N	%	MEAN	N	%	MEAN
Large	YY																		
	89	.	.	.	2	100.0	3.0	.	.	.	.	.	.	.	.	.	2	100.0	3.0
	90	1	7.7	2.0	9	69.2	3.0	3	23.1	4.0	.	.	.	.	.	.	13	100.0	3.2
	92	2	9.1	2.0	19	86.4	3.0	1	4.5	4.0	.	.	.	.	.	.	22	100.0	3.0
	93	4	13.8	2.0	22	75.9	3.0	3	10.3	4.0	.	.	.	.	.	.	29	100.0	3.0
	94	.	.	.	16	55.2	3.0	13	44.8	4.0	.	.	.	.	.	.	29	100.0	3.4
	95	.	.	.	29	47.5	3.0	32	52.5	4.0	.	.	.	.	.	.	61	100.0	3.5
	96	.	.	.	22	61.1	3.0	14	38.9	4.0	.	.	.	.	.	.	36	100.0	3.4
	97	1	6.7	2.0	11	73.3	3.0	3	20.0	4.0	.	.	.	.	.	.	15	100.0	3.1
	1984-91	1	6.7	2.0	11	73.3	3.0	3	20.0	4.0	.	.	.	.	.	.	15	100.0	3.1
	1992-96	6	3.4	2.0	108	61.0	3.0	63	35.6	4.0	.	.	.	.	.	.	177	100.0	3.3
	Total	8	3.9	2.0	130	62.8	3.0	69	33.3	4.0	.	.	.	.	.	.	207	100.0	3.3
Small	YY																		
	90	8	3.3	2.0	210	86.8	3.0	24	9.9	4.0	.	.	.	.	.	.	242	100.0	3.1
	91	2	2.1	2.0	89	93.7	3.0	4	4.2	4.0	.	.	.	.	.	.	95	100.0	3.0
	92	6	3.4	2.0	130	74.7	3.0	38	21.8	4.0	.	.	.	.	.	.	174	100.0	3.2
	93	28	3.1	2.0	752	84.3	3.0	112	12.6	4.0	.	.	.	.	.	.	892	100.0	3.1
	94	5	0.8	2.0	341	56.4	3.0	257	42.5	4.0	2	0.3	5.0	.	.	.	605	100.0	3.4
	95	1	0.1	2.0	519	39.2	3.0	766	57.8	4.0	37	2.8	5.0	2	0.2	6.0	1325	100.0	3.6
	96	1	0.1	2.0	475	50.6	3.0	448	47.8	4.0	14	1.5	5.0	.	.	.	938	100.0	3.5
	97	.	.	.	329	88.0	3.0	45	12.0	4.0	.	.	.	.	.	.	374	100.0	3.1
	1984-91	10	3.0	2.0	299	88.7	3.0	28	8.3	4.0	.	.	.	.	.	.	337	100.0	3.1
	1992-96	41	1.0	2.0	2217	56.4	3.0	1621	41.2	4.0	53	1.3	5.0	2	0.1	6.0	3934	100.0	3.4
	Total	51	1.1	2.0	2845	61.2	3.0	1694	36.5	4.0	53	1.1	5.0	2	0.0	6.0	4645	100.0	3.4

Appendix 5. Sea-age distribution of small and large Atlantic salmon of the Humber River

Angling

		SEA-AGE					
		1SW		1SW RS		Total	
		N	%	N	%	N	%
SIZE:	YY						
Large	88	1	100.0	.	.	1	100.0
	90	1	100.0	.	.	1	100.0
	92	3	100.0	.	.	3	100.0
	93	.	.	1	100.0	1	100.0
	94	3	100.0	.	.	3	100.0
	96	3	50.0	3	50.0	6	100.0
	97	3	75.0	1	25.0	4	100.0
	1984-91	2	100.0	.	.	2	100.0
	1992-96	9	69.2	4	30.8	13	100.0
	Total	14	73.7	5	26.3	19	100.0
Small	YY						
	88	77	100.0	.	.	77	100.0
	89	126	100.0	.	.	126	100.0
	90	55	98.2	1	1.8	56	100.0
	91	170	98.8	2	1.2	172	100.0
	92	342	99.7	1	0.3	343	100.0
	93	130	98.5	2	1.5	132	100.0
	94	331	99.1	3	0.9	334	100.0
	95	110	99.1	1	0.9	111	100.0
	96	289	99.0	3	1.0	292	100.0
	97	168	100.0	.	.	168	100.0
	1984-91	428	99.3	3	0.7	431	100.0
	1992-96	1202	99.2	10	0.8	1212	100.0
	Total	1798	99.3	13	0.7	1811	100.0

Appendix 6. Sea-age distribution of small and large Atlantic salmon of the Humber River

Tagging Traps

		SEA-AGE									
		1SW		2SW		1SW RS		2SW RS		Total	
		N	%	N	%	N	%	N	%	N	%
SIZE:	YY										
Large	89	.	.	2	40.0	3	60.0	.	.	5	100.0
	90	6	28.6	7	33.3	7	33.3	1	4.8	21	100.0
	91	.	.	.	.	4	100.0	.	.	4	100.0
	92	1	3.6	21	75.0	6	21.4	.	.	28	100.0
	93	1	1.8	28	50.0	10	17.9	17	30.4	56	100.0
	94	7	8.6	23	28.4	50	61.7	1	1.2	81	100.0
	95	4	2.9	57	40.7	77	55.0	2	1.4	140	100.0
	96	1	1.2	35	41.2	45	52.9	4	4.7	85	100.0
	97	.	.	15	21.1	53	74.6	3	4.2	71	100.0
	1984-91	6	20.0	9	30.0	14	46.7	1	3.3	30	100.0
	1992-96	14	3.6	164	42.1	188	48.2	24	6.2	390	100.0
	Total	20	4.1	188	38.3	255	51.9	28	5.7	491	100.0
Small	YY										
	90	242	95.3	.	.	12	4.7	.	.	254	100.0
	91	95	92.2	.	.	8	7.8	.	.	103	100.0
	92	175	96.7	.	.	6	3.3	.	.	181	100.0
	93	904	96.4	1	0.1	33	3.5	.	.	938	100.0
	94	608	97.9	.	.	13	2.1	.	.	621	100.0
	95	1327	99.5	.	.	7	0.5	.	.	1334	100.0
	96	942	97.8	.	.	21	2.2	.	.	963	100.0
	97	375	92.8	.	.	29	7.2	.	.	404	100.0
	1984-91	337	94.4	.	.	20	5.6	.	.	357	100.0
	1992-96	3956	98.0	1	0.0	80	2.0	.	.	4037	100.0
	Total	4668	97.3	1	0.0	129	2.7	.	.	4798	100.0